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ABSTRACT

The main goal of this study was to obtain insight about the factors that influence students' ability to learn during a field trip, in order to improve the planning and execution of learning field trips. The study was conducted in the context of a 1-day geological field trip for high school students in Israel. Three domains were tested by observations and questionnaires: (1) the nature of the learning activities during the field trip; (2) student attitudes to the field trip in which they had participated; and (3) changes in knowledge and attitudes following the field trip. Data were collected from the students, the teacher, and an outside observer before, during, and after the field trip. The research population consisted of 256 students in grades 9-11. Statistical procedures (t-test and analysis of covariance) were used in order to determine the effectiveness of age and preparedness on student performance during the field trip. It was found that the age variable had little significant influence and the preparedness variable was significantly more dominant. The learning activity of students who were prepared by studying a short unit that focused on cognitive preparation was significantly better than that of the other students. In order to determine variables that affect learning during a field trip, a multiple regression analysis was conducted. The regression included 22 different independent variables, which were grouped in three categories: background, pre-field trip, and field trip variables. Three variables were connected to student characteristics prior to the field trip and include knowledge level and type, acquaintance with the field trip area, and psychological preparedness. All together they define a "novelty space" for the student getting out on a field trip. It was concluded that reduction of this novelty space before the field trip can enhance learning performance during the field trip. (17 references) (KR)

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Factors which influence learning ability during a scientific field trip in a natural environment

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Introduction

Science teaching may have three types of learning environment: classroom, laboratory and outdoors. Of these three, the outdoor environment is the most neglected both by science educators and researchers. In a review of the literature published since 1930, Mason (1980) found only 43 empirical studies which dealt with the cognitive and affective outcomes of outdoor education. Most of them compared field trips to another teaching method. Another group of articles reported that teachers tend to avoid outdoor activities because they are frequently unfamiliar with their philosophy, techniques and organization of field trips (McCaw, 1980; Fido and Gayford, 1982; McKenzie et al. 1986). The lack of curriculum materials relevant to this type of activity is another major factor that inhibits teachers from conducting field trips (Mirka, 1970; Hickman ,1976; Mason, 1976). It would seem that the situation reflects our limited knowledge and understanding of the outdoor as a learning environment. Thus, it is suggested that to improve the planning and execution of learning field trips, research should focus on better understanding of the field as a learning environment.

Previous studies

In reports of research studies a recurrent theme is the effect of "novelty" on students' ability to benefit from field trips. Thus in a series of studies conducted at the Smithsonian Institution's Chesapeake Bay Center for Environmental Studies (Falk et al., 1978; Balling & Falk, 1979; Martin et al., 1981; Falk and Balling, 1982; Falk, 1983) focused on the psychological aspect of the field trip. They found that the ability of students to conduct cognitive tasks during a field trip, depends on the novelty of the field trip setting. For example, they showed that the learning performance of students acquainted with the field trip location was significantly better than those not so familiar. While the students in the "acquainted" group concentrated on the learning assignments, the students in the other group were involved mainly with exploring the physical surrounding. Similarly, Gottfried (1979) reported that students who were asked to conduct learning tasks in an unfamiliar setting, were first involved in sensorial operations and only, at a later stage, could some of them conduct also analytic operations.

However, unfamiliarity with the field trip setting is only one novelty factor which affect students' learning ability. In a case study on the learning performance of three high school classes during a four day geological campus in a desert area in Israel, Orion (1984) identified three such factors: previous knowledge of basic geological concepts relevant to the field trip, previous outdoor experience and previous acquaintance with the field trip location. These three factors identify a "Novelty Space" which contains cognitive and psychological components (Orion, 1989) (fig. 1).

Insert figure 1 here

The goals of the study presented here were a) to obtain insight and more information about the factors which influence student ability to learn during a field trip, and b) to base the novelty space hypothesis on a larger sample and quantitative data.

Characteristics of the geological field trip

The field trip used in this study was developed as an integral part of an introductory geology course for high school students and is based on a module which comprised a preparatory unit, a one-day field trip and a summary unit. The design was based on a number of criteria:

- didactic desirability (such as, a gradual move from the concrete to the abstract, first-hand experiences and factors that influence learning ability in the field).
- administrative (ease of organization)
- curricular (covering basic concepts by concrete activities)
- educational (the field trip should be a concrete learning event).

The module materials included a teacher's guide for the preparatory unit, a field trip booklet that directs student work at the learning stations and a series of mini-posters to help the teacher explain field observations.

The field trip area (from the foothills to the Judean mountains) was divided into seven learning stations, selected according to criteria described in Orion et al. (1986).

The study

a. Identification of the factors involved in a natural field trip

The geological field trip can be defined as a structured field trip in a natural environment. The factors which characterize the educational system of such a learning event can be grouped in three categories (Table 1).

Insert table 1 here

In order to control variables, the study was conducted using the same field trip under identical physical conditions for each group. Thus the trail factors, the teaching\learning method and the learning\teaching aids were the same for all the population. The independent variables were the student factors, the place of the field trip in the curriculum structure and the quality of the teacher.

b. Research questions and design

The main objective of the research was to investigate the factors which influence student learning ability during the field trip. Three domains, that could be tested by observations and questionnaires:

- The nature of the learning activities during the field trip.
- student attitudes towards the field trip in which he was participated.
- changes in knowledge and attitudes following the field trip.

Data was collected from three different points of view - student, teacher and outside observer - and at three stages: pre, post and during the field trip. The variables assessed in each of the research stages are shown in Figure 2.

Insert figure 2 here

The research structure enables to indicate knowledge and attitudes developed following the field trip and to relate it to the event itself.

c. Research inventories

The research questions were answered using seven different inventories. Four of them were specially developed, and the other three were modified for the purposes of this research. A description of the inventories, their domains and place in the research structure is given in Table 2.

Insert table 2 here

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d. Research population

The research population consisted of 296 students from 8 high schools. Only students whose data base included all the variables were selected from total number of 500 geography students in 17 grade 9-11 classes. The research population was heterogeneous in two variables: age and preparedness for the field trip.

- Age: The student population was divided into two sub-groups grade 9-10 grade 11. Grade 11 in Israel are discipline oriented and therefore smaller and more homogeneous than lower grades.

- Preparedness: The population was divided into three groups, according to the preparedness type reported by teachers classified by: length, emphases and place in the curriculum.

"Optimal concrete" preparedness group (OCP) — consisted of six grade 11 classes (N=98) who followed the preparatory unit to the letter. This 10 hour teaching unit includes: cognitive preparation based upon hands-on activities, psychological preparation involving detailed description of the coming learning event and geographical preparation with slides, maps and a video film.

"Minimal concrete" preparedness group (MCP) — consisted of three grade 11 classes and two grade 9-10 classes (N=101), whose preparatory unit included only a short activity of rock and soil identification (3 hours).

"Traditional frontal" preparedness group (TFP) — consisted of three grade 11 classes and three grade 9-10 classes (N=97), who studied the entire course (30 hours) in a conventional manner and only later participated in the field trip. The teachers of this group perceive the field trip in a traditional way, namely as a summary or as enrichment to the entire course. Field trip topics were taught at least one month before the event and the students were not skilled in rock and soil identification, since the course did not include hands on activities. No special preparation for the event was given, neither psychological nor geographical.

Results and discussion

There is an overlap between the age variable and the preparedness variable, since OCP includes only grade 11 classes. In order to control these variables two kind of analysis were conducted:

Control for the preparedness variable: Through a comparison of the two age sub-groups who were similarly prepared.

Control for the age variable: Through a comparison of OCP and TFP grade 11 students. (No significant differences were found between the MCP and TFP groups.)

Control for preparedness

A comparison between the two grade groups who were similarly prepared, provides a control for the preparedness variable. If the grade variable is more dominant than the preparedness variable, one would expect that attitude and knowledge levels of grade 11 classes would be significantly higher than those of grades 9-10. Table 3 presents the results of a t test between the mean attitudes of the two age sub-groups towards the field trip in which they had participated. A measurement of the influence of the field trip on knowledge and attitude was conducted using analysis of covariance (ANCOVA) - see Table 4. The covariate in this last analysis is the respective measure of the scale.

Insert tables 3 and 4 here

As can be seen, there are only few significant differences between the two age subgroups. The attitude of the grade 9-10 subgroup to "teaching" and "individualized learning" was significantly higher than the grade 11 subgroup (Table 3). Also the grade 11 group developed a higher attitude level to individualized learning during a field trip and to the adventurous aspect (Table 4).

The differences that were found in the individualized learning scale may suggest that the learning performance of the grade 11 group in the field was more effective. The contradiction between this and the finding, shown in Table 3, that the attitudes of the grade 9-10 group to their individualized learning performance during the field trip were higher than the older subgroup, could be explained by the self criticism factor which develops with age. It is important to note, that on the basis of the observational reports, no significant differences were found between the two groups with regard to their behavior in the field. They both demonstrated medium to low learning performance and high social type interactions.

Although there are slight differences related to age, the overall conclusion from these results would seem suggest that the age variable had little significant influence.

Control for age

In order to control for the age variable and to emphasize preparedness, two grade 11 sub-groups were compared - one drawn from OCP and the the other from TFP. The comparison was made by a t test between the mean attitudes of the two sub-groups to the field trip in which they had participated (Table 5). and by an analysis of covariance to determine knowledge and attitude developed following the field trip. (Table 6), The covariate is the respective pretest measure of the scale.

Insert tables 5 and 6 here

The findings summarized in Tables 5 and 6 suggest that preparedness has a significant influence on learning ability . The learning activity of students, who were prepared by studying a unit that focused on the three novelty factors, was significantly better than that of the other students. This finding was strongly supported by the observational reports.

The ability of the OCP subgroup to cope better with the learning assignments is expressed by their attitudes and knowledge following the field trip. The significant difference in problem solving in

the achievement test, reflects the knowledge gained through the field trip. It is thus suggested that students who participated in the field trip after strong concrete preparatory learning, could cope more successfully with the new problems which they faced in the field.

Factors which may influence learning during a field trip

In order to determine variables which affect learning during a field trip, a multiple regression analysis was conducted (Table 7). The regression included 22 different independent variables which were grouped in three categories: background, pre field trip and field trip variables (see Table 2).

The dependent variable — "learning efficiency during the field trip" is presented in the multiple regression by students attitudes towards their individualized learning (Table 2, questionnaire E). This variable was chosen since the main purpose of a learning field trip is the direct interaction between student and the concrete surrounding. The individualized learning level can be seen as a standard for the learning ability of students in the field.

Insert table 7 here

Five independent variables explain 40% of the total variance. Only one of the field trip variables — "teacher and teaching/learning aids" - which explains 16% of the variance influenced students' individualized learning during the field trip. This variable relates to student attitudes to the teaching/learning components of the field trip (such as, quality of booklet which guided their individualized learning, mini-posters used by the teacher, team learning, class discussion and quality of the field trip teacher). This finding can be seen as an encouraging evaluation of the curriculum package and the educational strategies used in this particular field trip.

Three pre field trip variables explain together 21% of the variance. Thus, the pre field trip variables have greater influence on the students learning ability during the field trip, than the one field trip variable. It is important to notice, that these three variables are very similar to the three components of the novelty space (Fig. 1) explained as follow:

Preparedness type: this variable is mainly related to the type of knowledge the students acquired before the field trip. A correlation test (Pearson) which was conducted between this variable and all the other pre field trip variables, gave significant correlation with only two of the variables: a) achievement in rock identification and b) achievement in "rock formation environments". It would thus seem that this variable represents the "previous knowledge" factor (i.e., cognitive component of the novelty space).

Students attitude to field trip as a learning aid: this variable tests students mental readiness for a field trip as a learning event. This variable is comparable to "previous outdoor experiences" of the novelty space and we suggest that this variable can be regard as the psychological component of the novelty space.

Acquaintance with the geographical cross section through the field trip area: There is a clear overlap between this variable and the "acquaintance with the field trip area" factor of the novelty space.This variable can be regarded as the geographical component of the novelty space.

One background variable - grade - explained 3% of the variance. This finding supports the previous results and conclusions, i. g., that grade has a certain (but small) effect on learning efficiency during a field trip.

Thus learning efficiency during the field trip was influenced by two main sources; the field trip program and the novelty space of the students.

SUMMARY

The field trip is one of the most complex and expensive activities in the educational system. Therefor, it is important to achieve optimal educational results that will justify the investment.

There are at least 22 variables which influence, at different levels, the learning efficiency in the field. These variables fall into three groups: background, pre-field trip and field trip variables. Some of them are connected to teaching variables, some to the students and some to field trip components. In addition to the field trip variables, only three variables were found to have a significant influence on learning ability of students. These three variables are connected to student characteristics prior to the field trip: a) knowledge level and type, b) acquaintance with the field trip area and c) psychological preparedness. All together they define a "novelty space" for the student getting out on a field trip. If this novelty space reduced before the field trip than we can expect enhanced learning performance during the field trip. This suggests that a field trip should be planned as an integral part of the curriculum rather than as an isolated activity. The field trip should be early in the concrete part of the total learning activity, and it should be preceded by a relatively short preparatory unit that focuses on limiting the novelty space factors.

The psychological novelty factor of the population in this research is explained by their previous experiences in field trips as a social-adventurous events rather than learning activities. It can be assumed that as such students are exposed to learning field trips, the effect of this psychological factor will be decreased considerably.

In spite of some progress made here in understanding the field trip learning environment, there is still much research to be done. For example, a) following the same group of students over several field trips and b) comparing factors which influence learning during nature field trips with those which influence indoors field trips such as museums.

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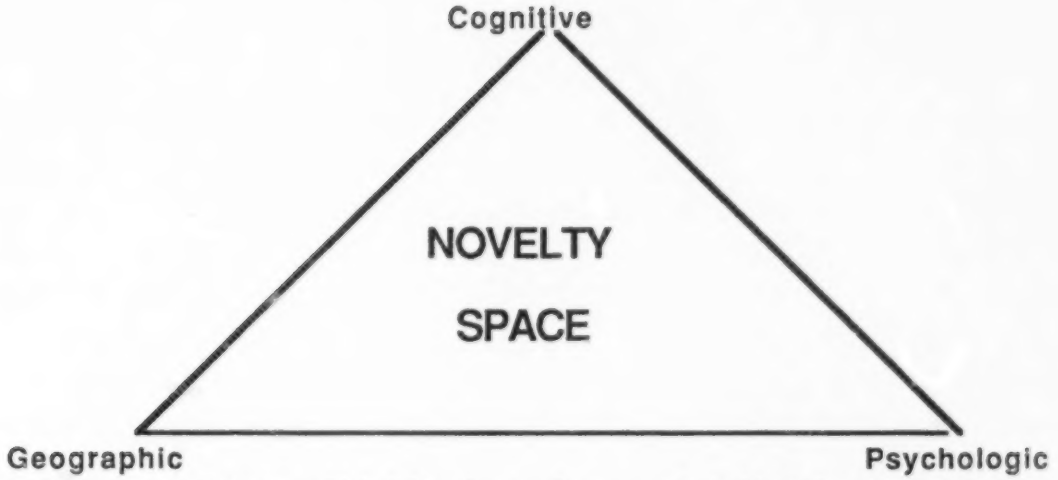

Figure 1: The three factors which define the novelty space of a field trip learning environment

Teaching factors	Trail factors	Student factors
1. Place of field trip in curriculum structure.	1. Quality of learning conditions at each station.	1. Previous knowledge of trip topics.
2. Teaching/learning method.	2. Duration of trail.	2. Previous acquaintance with trip area.
3. Teaching and learning aids.	3. Attractiveness of trail.	3. Previous experience in field trips.
4. Quality of teacher.	4. Weather conditions during field trip.	4. Previous attitudes to subject matter
		5. Previous attitudes to field trips
		6. Class composition (e.g., age and science orientation.
		7. Class size.

Table 1: The categories and factors which define the natural field trip educational system

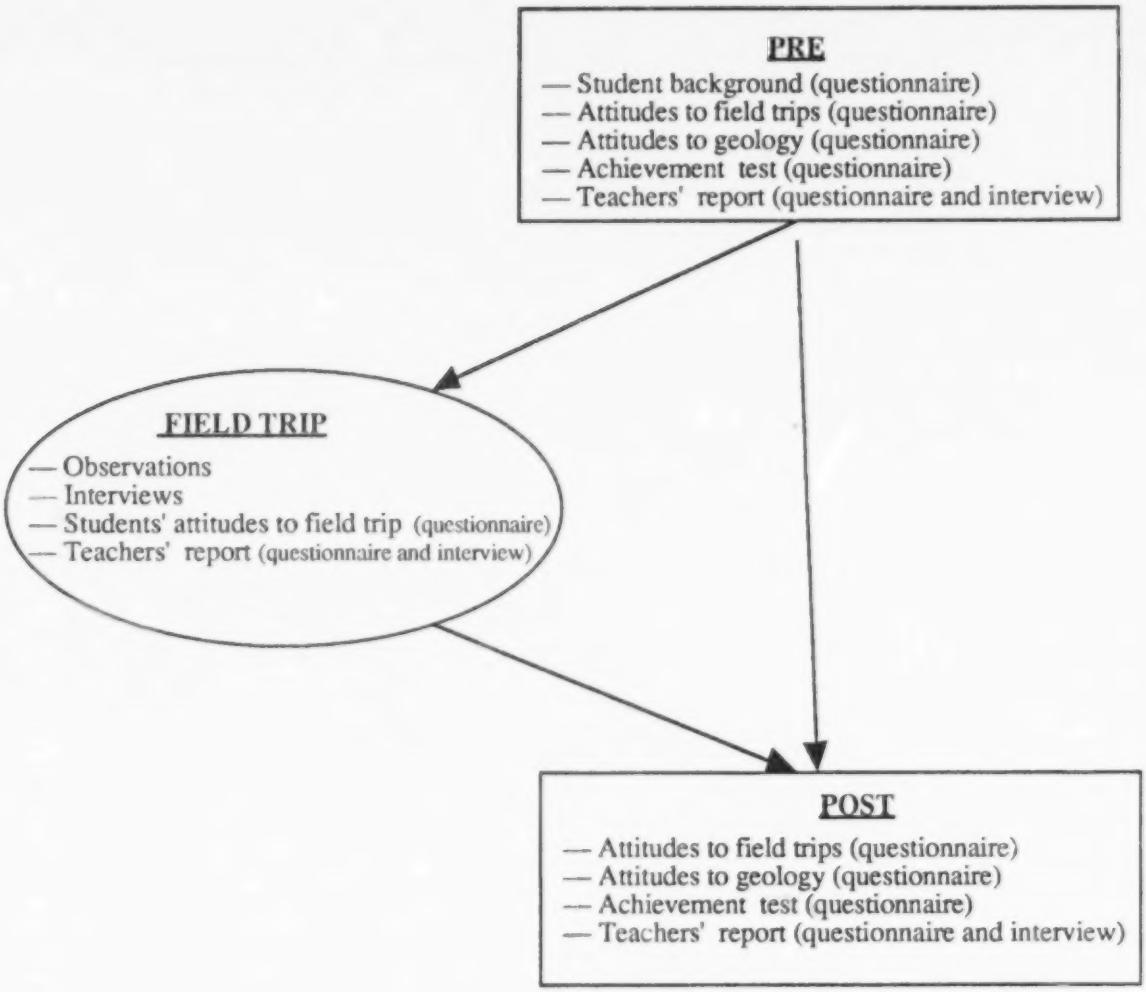
PRE
— Student background (questionnaire)
— Attitudes to field trips (questionnaire)
— Attitudes to geology (questionnaire)
— Achievement test (questionnaire)
— Teachers' report (questionnaire and interview)
FIELD TRIP
— Observations
— Interviews
— Students' attitudes to field trip (questionnaire)
— Teachers' report (questionnaire and interview)
POST
— Attitudes to field trips (questionnaire)
— Attitudes to geology (questionnaire)
— Achievement test (questionnaire)
— Teachers' report (questionnaire and interview)

Figure 2: The research structure

Inventories	Objectives of inventory and its variables	Place in research structure
A. Information questionnaire * *	Student background variables: 1. previous experience in the field. 2. previous experience in field trips based on individualized learning. 3. acquaintance with field trip area.	Pre
B. Attitude questionnaire * * (Likert) (Orion&Hofstein, 1990)	Attitudes to field trips: 4. field trip as a learning tool. 5. individualized learning as learning method during a field trip. 6. field trip as social event. 7. field trip as adventurous event. 8. environmental aspect of field trip.	Pre\Post
C. Attitude questionnaire * (Semantic differential)	Attitudes to learning geology: 9. discipline difficulty. 10. enjoyment and interest. 11. importance of discipline.	Pre\Post
D. Achievement questionnaire * * (Multiple choice)	Knowledge level: 12. rock and soil identification. 13. rock formation environments. 14. problem solving related to observations.	Pre\Post
E. Attitude questionnaire * * (Likert)	Attitudes to the specific field trip: 15. enjoyment and interest. 16. teacher and teaching aids. 17. individualized learning during field trip. 18. physical difficulty.	At end of field trip
F. Observation schedule * *	Student activity during field trip: 19. behavior of students at each learning station. 20. time duration of learning activity at each learning station. 21. interest, enthusiasm and understanding.	During the field trip
G. Teacher report *	Teacher report about: 22. preparation of field trip. 23. observations in field trip. 24. student response in class, after field trip.	After preparatory unit and after field trip event

Table 2: General description of research tools

* * Inventories first developed for this study.
* Inventories modified for this study.

	9—10 (MCP+TFP) N = 110		11 (MCP+TFP) N = 80			
Scales (Likert 1—4)	Mean	S.D	Mean	S.D	t	P
Enjoyment and interest	3.0	0.5	3.1	0.5	1.9	N.S
Teacher and teaching aids	3.2	0.4	3.0	0.5	3.0	0.003
Individualized learning	3.0	0.4	2.8	0.5	3.4	0.001
Physical difficulty	3.2	0.4	3.4	0.7	1.4	N.S

Table 3: A t test analysis comparing mean attitudes of the two age sub-groups (questionnaire E).

		9-10 (MCP+TFP) N = 110		11 (MCP+TFP) N = 77			
Inventory	Scales	Stand. Mean	S.E	Stand. Mean	S.E	F	P
General attitudes to a field trip (Likert 1-4)	Learning tool	3.3	0.04	3.25	0.04	0.01	N.S
	Individualized learning	2.4	0.05	2.6	0.06	5.2	0.02
	Adventurous event	2.7	0.05	3.0	0.06	17.4	0.0001
	Social event	2.8	0.04	2.8	0.04	0.6	N.S
	Environmental aspect	3.0	0.04	3.0	0.04	0.9	N.S
Attitudes to geology (Sem. Dif. 1-7)	Cognitive aspect	4.7	0.07	4.7	0.09	0.4	N.S
	Affective aspect	4.8	0.08	4.9	0.1	1.8	N.S
	Importance	5.2	0.09	5.4	0.1	1.7	N.S
Achievement test (1—100)	Rock identification	55	2.5	59	3.1	0.7	N.S
	Formation of rocks	65	2.0	68	2.5	0.5	N.S
	Problem solving	56	1.8	61	2.3	2.6	N.S

Table 4: Analysis of covariance (ANCOVA) between attitude and achievement of the two age subgroups (questionnaires B, C, D).

	11 (OCP) N = 55		11 (TFP) N = 56			
Scales (Likert 1—4)	Mean	S.D	Mean	S.D	t	P
Enjoyment and interest	3.1	0.4	3.1	0.5	0.1	N.S
Teacher and learning aids	3.2	0.3	3.0	0.5	2.6	0.01
Individualized learning	3.1	0.3	2.8	0.5	3.7	0.0003
Physical difficulty	3.2	0.8	3.5	0.7	1.6	N.S

Table 5: A t test analysis comparing mean attitudes of two preparedness subgroups (questionnaire E).

Inventory	Scales	11 (OCP) N = 55 Stand. Mean	S.E	11 (TFP) N = 56 Stand. Mean	S.E	F	P
General attitudes to a field trip (Likert 1-4)	Learning tool	3.4	0.06	3.2	0.06	5.9	0.02
	Individualized learning	3.0	0.06	2.6	0.06	15.5	0.0002
	Adventurous event	2.6	0.05	2.8	0.05	5.6	0.02
	Social event	2.8	0.06	3.0	0.06	4.5	0.04
	Environmental aspect	3.0	0.06	3.0	0.06	0.5	N.S
Attitudes to geology (Sem. Dif. 1-7)	Cognitive aspect	4.7	0.1	4.7	0.1	0.0	N.S
	Affective aspect	5.2	0.1	5.2	0.1	2.6	N.S
	Importance	5.5	0.1	5.4	0.1	0.1	N.S
Achievement test (1—100)	Rock identification	65	3.8	62	3.7	0.3	N.S
	Formation of rocks	71	2.9	69	2.9	0.2	N.S
	Problem solving	67	2.5	58	2.5	6.3	0.01

Table 6: Analysis of covariance (ANCOVA) between the two preparedness sub-groups on attitude and achievement (questionnaires B, C, D).

Independent variables	Variable sub-group	ß	ΔR^2	R^2	F ($_{\Delta R^2}$)	P (F)
1. Teacher and teaching/learning aids	Field trip variables (Variable No. 19)	0.40	0.15	0.15	60	0.0001
2. Preparedness type	Pre field trip variables (Variable No. 15)	0.10	0.10	0.25	30	0.0001
3. Field trip as a learning aid	Pre field trip variables (Variable No. 7)	0.20	0.09	0.34	22	0.0001
4. Student score of geographical cross-section of field trip area	Pre field trip variables (Variable No. 6)	0.09	0.03	0.37	7	0.01
5. Grade	Background variables (Variable No. 2)	-0.15	0.03	0.40	9	0.002

Table 7: Multiple regression of background, pre field trip and field trip variables and their relations with student attitudes to their individualized learning during the field trip (N=210).